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L. O. HOWARD, Entomologist and Chief of Bureau.

FLOUR PASTE AS A CONTROL FOR RED SPIDERS AND AS A SPREADER FOR CONTACT INSECTICIDES.

BY

WILLIAM B. PARKER,
Entomological Assistant.

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RESULTS OF EXPERIMENTS.

During some spraying experiments for the control of the red spider (*Tetranychus bimaculatus* Harv.) on hops in 1912 some difficulty was

FIG. 1.—Lime-sulphur mixture and flour paste (left half), showing spreading effect of flour paste; lime-sulphur mixture straight (right half), showing beaded effect due to lack of flour paste. (Original.)

experienced in obtaining an effective spreader for the lime-sulphur solutions, due to the fact that soap forms a precipitate with the calcium polysulphid. While testing the following combination—flow-

ers of sulphur 15 pounds, water 100 gallons, and flour paste (as a "sticker") 4 gallons—a formula advised for red spiders in Bulletin No. 154 by Mr. W. H. Volck of the California Experiment Station, it was observed that the mixture spread over the leaves very readily. The flour paste was evidently the spreader and was accordingly mixed with the lime-sulphur solutions. The result was a smooth mixture which spread over the foliage very readily and gave unusual results as an arachnicide. The proper proportions were found to be 4 gallons of paste (4 pounds of flour) to 100 gallons of spray. Table I graphically represents the relative effectiveness of the lime-sulphur spray, with and without the flour paste, for the red spider on hops.

TABLE I.—*Relative effectiveness of lime-sulphur spray, with and without flour paste, against the red spider on hops in the Sacramento Valley of California, in 1912.*

Formula.	Number of mites present.	Number of mites killed.	Per cent of mites killed.
Lime-sulphur, 36° Baumé, 1–75; flour paste, 4–100	698	692	99.0
Lime-sulphur, 36° Baumé, 1–75	360	135	37.5

From the foregoing table it is very evident that the use of flour paste greatly increases the efficiency of the lime-sulphur spray and that without the paste the spray was very ineffective. These results were substantiated by other experiments and, by a check experiment with the flour paste, 4–100, used without the lime-sulphur, it was found that the increased efficiency was mainly due to the spreading effect of the paste.

Having proved a most efficient, cheap, and convenient spreader for the lime-sulphur solutions, some experiments were conducted with flour paste in combination with nicotine sulphate upon the hop aphis (*Phorodon humuli* Schrank). (See Table II.)

TABLE II.—*Results obtained by spraying with combinations of flour paste and nicotine sulphate in different proportions against the hop aphis, Sacramento Valley of California, 1912.*

Formula.	Number of aphides present.	Aphides killed.	Cost per 100 gallons.
		Per cent.	*Cents.*
Nicotine sulphate, 1–2,000; flour paste, 4–100	627	100	0.71
Nicotine sulphate, 1–2,500; flour paste, 4–100	611	100	.60
Nicotine sulphate, 1–3,000; flour paste, 4–100	1,668	99	.50
Nicotine sulphate, 1–3,000; flour paste, 4–100	148	99	.50

From the preceding table it is very evident that flour paste, 4–100, is a very effective spreader for nicotine sulphate.

The efficiency of flour paste as a spreader was very evident to the writer, but it was deemed advisable thoroughly to illustrate this point.

Two hopvines were accordingly sprayed, one with lime-sulphur straight and the other with lime-sulphur and flour paste, 4–100. The relative spreading effect of these two sprays is shown in figure 1. The left half of the figure represents the lime-sulphur and the flour paste in combination, while the right half represents the lime-sulphur straight. The spotted effect produced by the lime-sulphur mixture alone is in strong contrast to the even appearance of the other half of the illustration.

During some spraying experiments with nicotine sulphate and flour paste upon the hop aphis it was observed that many of the smaller aphides had become pasted onto the leaves. From this data it was assumed that a stronger solution of paste would be effective against the more delicate aphides and mites, and the following experiments were conducted upon the red spider.

TABLE III.—*Results of experiments with flour paste sprayed against the red spider on hops in the Sacramento Valley of California, 1912.*

Date.	Formula.	Number of mites present.	Mites killed.	Cost per 100 gallons.
			Per cent.	*Cents.*
June 18	Flour paste, 8–100	435	100	17.6
June 27	.....do	781	99.8	17.6
July 12	.....do	452	99.8	17.6
Aug. 6	.....do	882	100	17.6
	.....do	477	100	17.6
Aug. 9	.....do	732	99.8	17.6
	Total count	3,759	.....	.....
	Average	.....	99.9	.....
July 16	Flour paste, 10–100	805	99.9	22
Aug. 6	.....do	908	99.9	22
	Total count	1,712	.....	.....
	Average	.....	99.9	.....

These experiments prove that flour paste, 8–100 and 10–100. is effective against *Tetranychus bimaculatus*. The paste has no effect upon the eggs, however, and in controlling the mites a second application 7 to 10 days after the first is necessary to catch the mites that emerge from the eggs.[1]

A few preliminary experiments were conducted with this material upon *Tetranychus mytilaspidis* Riley which was attacking pears, with very encouraging results, and it is very probable that flour paste, 8–100, will give good results when applied for any of the small leaf-feeding mites.

The last of June, 1912, flour paste, 8–100, was applied for the hop aphis (then in the younger stages) with a 97 per cent efficiency. These were encouraging results, but later experiments proved that,

[1] In moderate weather allow 10 days and in hot weather 7 days between applications.

although the solution was effective against some very delicate species and the younger stages of the hop aphis, it was not effective against the stouter aphides.

When the paste was dry the mites and more delicate aphides treated were found firmly pasted onto the leaves. Later the paste film was observed to crack and partially scale off, leaving the leaf free to perform its natural functions.

The neutrality of this spray was proved by the fact that when applied upon the foliage and blossoms of the hop in proportions as high as 12 pounds to 100 gallons no injurious effect resulted. When sprayed onto the burrs and delicate hop cones it did not prevent pollination or injure the appearance of the scales.

Flour paste has proved effective when applied for red spiders upon the following plants:

Beans.
Chrysanthemum (may spot leaves if used too near blossoming time).
Hops.
Cucumber, greenhouse and field.
Pumpkin.
Pear.
Prune.
Roses in field.
Violets, field and greenhouse.

The flour paste was not satisfactory when used for the red spider on greenhouse roses (did not spread well), greenhouse carnations, or field sweet peas.

PREPARATION OF PASTE.

To prepare the flour paste, mix a cheap grade of wheat flour with cold water, making a thin batter, without lumps; or wash the flour through a wire screen with a stream of cold water. Dilute until there is 1 pound of flour in each gallon of mixture. Cook until a paste is formed, stirring constantly to prevent caking or burning. Add sufficient water to make up for evaporation.

Flour paste may also be prepared by stirring boiling water into a moderately thin batter until there is 1 pound of flour in each gallon of mixture and allowing it to stand until the starch is all broken down.

If the paste is not sufficiently cooked, the resulting spray will not be effective, and if overcooked the paste will harden when thoroughly cool, and will not mix with water very readily. Usually, however, the paste is used as it is prepared, and overcooking is not a disadvantage.

When mixed in the spray tank flour paste has a tendency to settle, and in order to do satisfactory work agitation is necessary. This is but a slight disadvantage, and is necessary with most materials.

Flour paste appears to be a very effective spreader for lime-sulphur and nicotine-sulphate sprays. Cheap flour can be purchased

for less than half the cost of whale-oil soap. It is always obtainable, and having no odor it is less offensive to use than the whale-oil and fish-oil soaps. When used alone at the rate of 8 gallons (8 pounds flour) to 100 gallons of water it is effective against several leaf-feeding mites and some very delicate aphides. The possibility

FIG. 2.—Hindu making flour paste, Sacramento Valley, Cal., 1912. (Original.)

of its use as a spreader for lime-sulphur sprays for scale insects and fungi and as a "sticker" for arsenicals has not yet been worked out, but from observations during the past four months it is believed that it may have some value along these lines.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *November 23, 1912.*

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